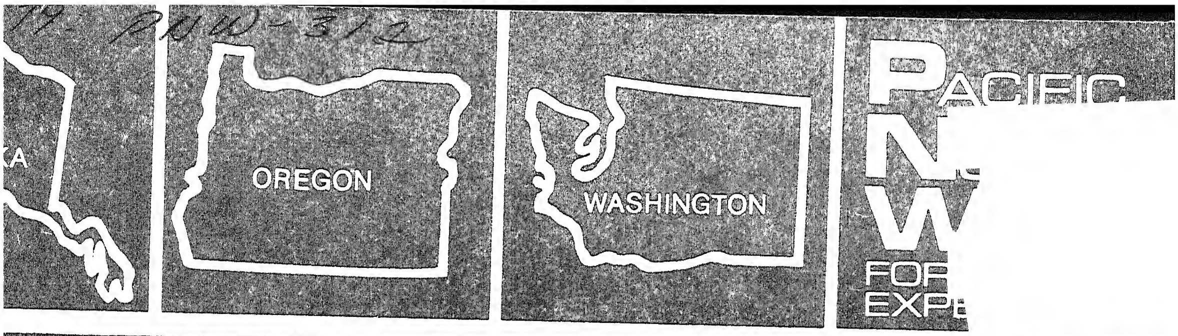

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SEEDING HABITS OF UPPER-SLOPE TREE SPECIES

IV. SEED FLIGHT OF NOBLE FIR AND PACIFIC SILVER FIR

by

Richard E. Carkin, *Forester*, Jerry F. Franklin, *Chief Plant Ecologist*,

Jack Booth, *Forestry Technician*, and Clark E. Smith, *Forestry Technician*[1/]

ABSTRACT

Noble and Pacific silver fir seed fall declined rapidly as distance from uncut timber at the edge of clearcuts increased. Observations were made at four locations in the Washington and Oregon Cascade Range. There were no differences in dispersal of sound and unsound noble fir seed but unsound Pacific silver fir seed dispersed farther than sound seed. Pacific silver fir had a higher percentage of sound seed than noble fir had for the same seed year. Differences in effectiveness of east and west cutting boundaries in seed dispersal were not consistent.

KEYWORDS: Seed dispersion, elevation, noble fir, *Abies procera*, Pacific silver fir, *Abies amabilis*, clearcutting systems.

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[1/] Clark E. Smith is no longer employed by the Pacific Northwest Forest nd Range Experiment Station.

INTRODUCTION

A research program on natural regeneration of upper-slope forests in the Pacific Northwest was begun in 1961 with a long-term study of cone production of major timber species (Franklin 1968, Franklin et al. 1974). In 1967 the research was extended to include production of viable seed and seed dissemination throughout clearcut areas.

This note reports data on seed flight of noble fir (*Abies procera* Rehd.) and Pacific silver fir (*Abies amabilis* (Dougl.) Forbes) for 1968-69 and 1971-72 seed years in the Washington and Oregon Cascade Range. Earlier reports have described the flight of seeds from mountain hemlock (*Tsuga mertensiana* (Bong.) Carr.) (Franklin and Smith 1974a), and mixed white fir (*Abies concolor* (Gord. & Glend.) Lindl.) and Shasta red fir (*A. magnifica* var. *shastensis* Lemm.)(Franklin and Smith 1974b). This note describes relationships between seed fall and distance from the uncut timber at the edge of a clearcut. Results provide general information concerning seed supply for natural regeneration of these species. The data should be helpful in selecting size of clearcut where natural regeneration will be used to establish part or all of the new crop.

STUDY AREA

The study areas were located in the Willamette National Forest in Oregon and Gifford Pinchot National Forest in Washington (table 1). Three areas were selected primarily for their noble fir and the fourth area was selected for its Pacific silver fir[2/]. Each area

[2/] Initially two study areas were selected to represent Pacific silver fir for the 1968-69 and 1971-72 seed years. Vandalism reduced data so that one area had to be removed from the study. The other area, Mosquito Lake, though vandalized, had a usable 1968-69 seed year collection.

Table 1--*Location and physical characteristics of study areas*

Area	National Forest	Ranger District	Topography	Elevation	
				Feet	Meters
Wildcat	Willamette	McKenzie Bridge	Moderate to steep mountain slopes	4,800	1 465
Bingham Ridge	Wilamette	Detroit	Very gently sloping	5,000	1 525
Sleeping Beauty-Ninefoot Creek	Gifford Pinchot	Mount Adams	Moderate slopes on a ridge	4,000	1 220
Mosquito Lake	Gifford Pinchot	Mount Adams	Gently undulating	3,900	1 190

had transects from both an east and a west uncut edge of a clearcut (fig. 1). In two areas (Wildcat and Sleeping Beauty-Ninefoot Creek) the east and west transects were on different clearcuts. Bingham Ridge had a narrow clearcut and shared the 375-foot (114-m) transect.

Physical features of each area were recorded, and the uncut timber stand was inventoried to characterize the seed source. The basal area of species of trees 5 inches (13 cm) d.b.h. and larger was recorded for 1-acre (0.4-ha) plots at both the east and west edge of uncut timber (table 2).

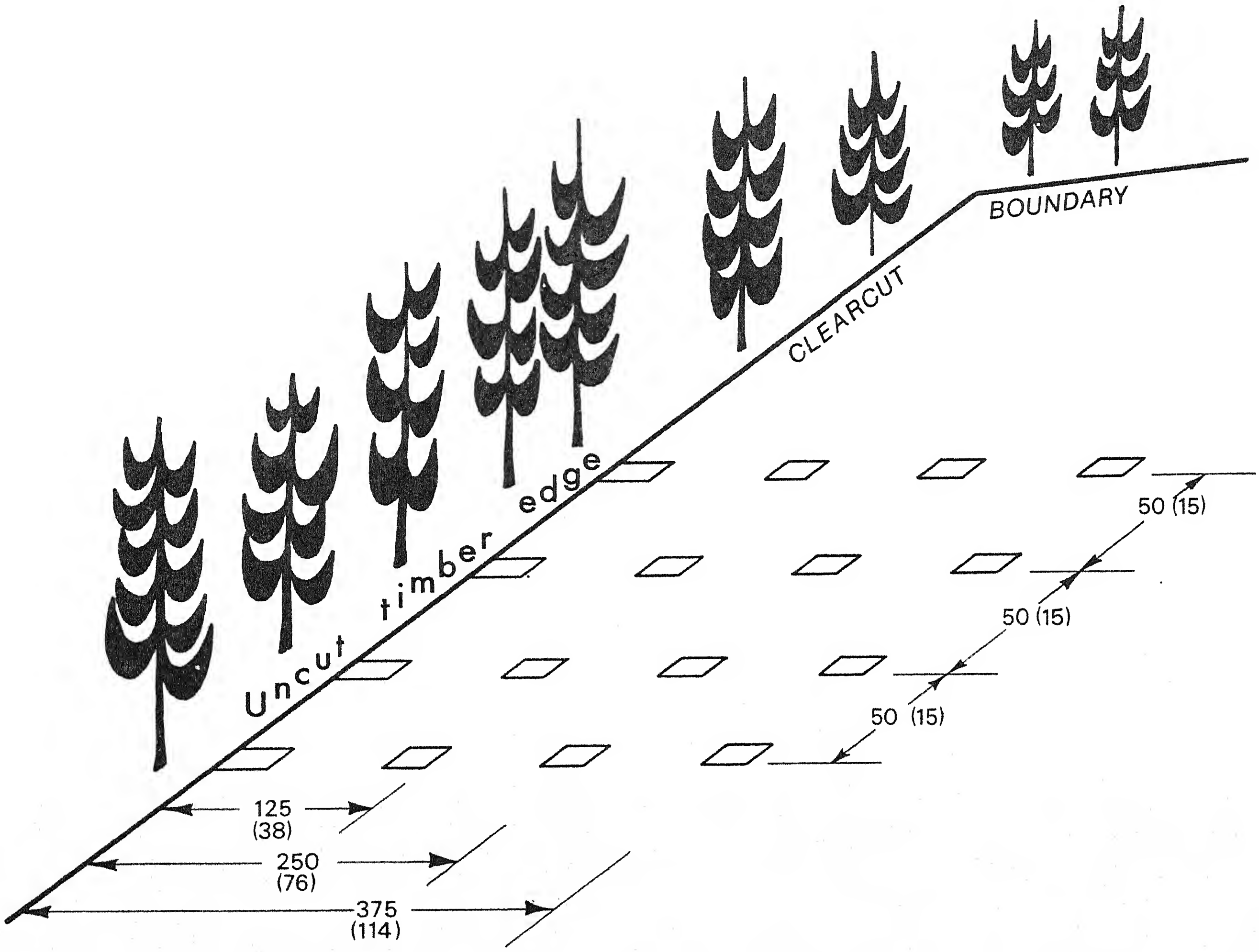


Figure 1.--Arrangement of seed trap transects from an east or west seed source in feet (meters).

Table 2--*Basal area of uncut trees*[1/] *on edges of study areas, in square feet per acre (square meters per hectare)*

Area	Edge	Trees per		Noble fir	Pacific silver fir	Douglas-fir	Grand fir	Mountain hemlock	Western hemlock	Western white pine	Total
		acre	hectare								
Wildcat	East	194	479	229 (53)				1 (0.2)			230 (53)
	West	100	247	379 (87)		85 (20)	4 (1)	1 (.2)		3 (0.7)	472 (109)
Bingham Ridge	East	182	449	410 (94)		122 (28)	1 (.2)	11 (3)		7 (1.6)	551 (127)
	West	150	370	171 (39)		265 (61)	8 (2)		1 (.2)		445 (102)
Sleeping Beauty-Ninefoot Creek	East	147	363	195 (45)	4 (1)	229 (53)			1 (.2)		429 (99)
	West	172	425	213 (49)		250 (57)			17 (4)		480 (110)
Mosquito Lake	East	163	403		257 (59)			44 (10)	6 (1.4)	8 (2)	315 (72)
	West	93	230		285 (65)			29 (7)		8 (2)	322 (74)

1/ Basal area and trees per acre are for trees over 5 inches (13-cm) d.b.h. on a 1-acre (0.4-ha) plot.

METHODS

Numbers of seed falling at various distances from the stand edge were measured by catching seed in 1- by 2-foot (0.3- by 0.6-m) seed traps. The seed traps were placed along transects at right angles from the timber edge toward the center of each clearcut (fig. 2). Sixteen seed traps were used in each transect; four traps were placed at 0, 125, 250, and 375 feet (0, 38, 76, and 114 m) from the edge of the timber (fig. 2). Seed traps followed Herman's (1963) design with an additional crossmember in the top half to support the heavy snow loads characteristic of Pacific Northwest high-elevation areas. Seed were collected about October 1 and November 1 and again the following spring as soon as snowmelt occurred. Seed soundness was determined by a cutting test.

Regression analyses were calculated for total seed fall and sound seed fall for each transect by distance from stand edge. Other regressions were calculated separately and in combination for the 1968-69 and 1971-72 seed years. The regression model was

$$\text{Log } (y+1) = a + b(1/(x+1)) \quad ;$$

where, y = number of seed per trap and x = distance from stand edge.

RESULTS

Seed fall rapidly declines as distance from the stand edge increases. This pattern is similar for both seed years (fig. 3). The regression model was fitted to the data; results of the statistical tests are found in table 3. Noble fir seed fall declines more rapidly than that of Pacific silver fir (table 4). At 125 feet (38 m) Pacific silver fir seed fall is nearly the same as at the stand edge, but noble fir seed fall

WILDCAT—East and west transects are in separate clearcuts.

BINGHAM RIDGE—Since clearcut is narrow, east and west transects share the 375-foot (114-m) set of seed traps.

SLEEPING BEAUTY-NINEFOOT CREEK—East and west transects are on separate clearcuts several miles apart on opposite sides of a common ridge.

MOSQUITO LAKE—East and west transects in the same clearcut.

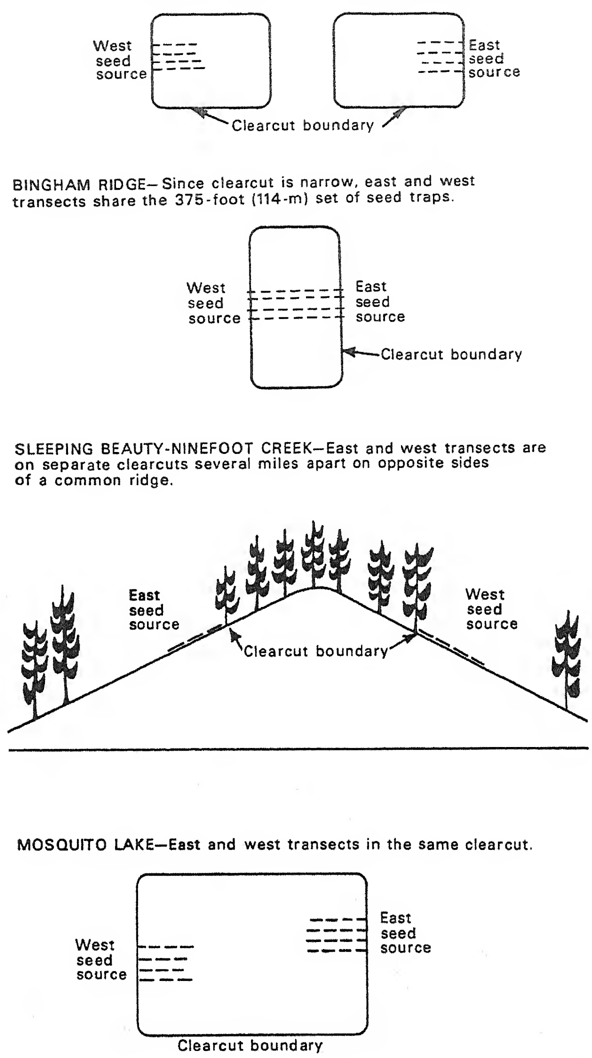
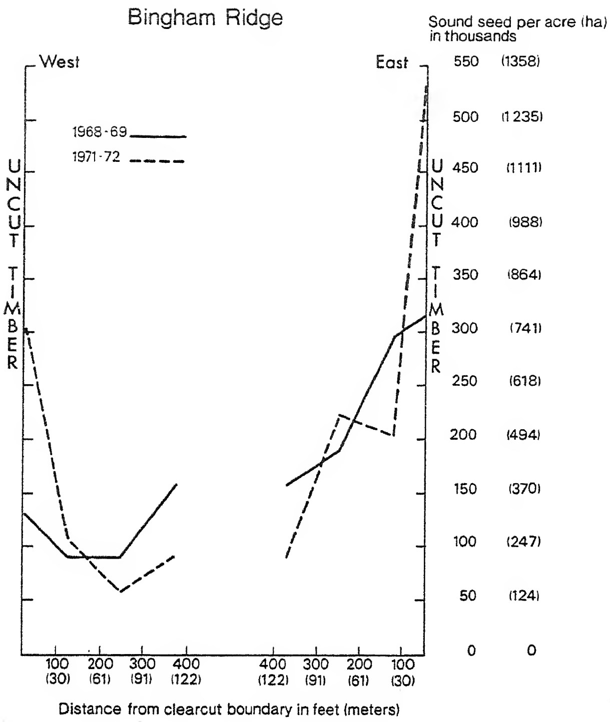


Figure 2.--Description and layout of clearcuts and seed trap transects.



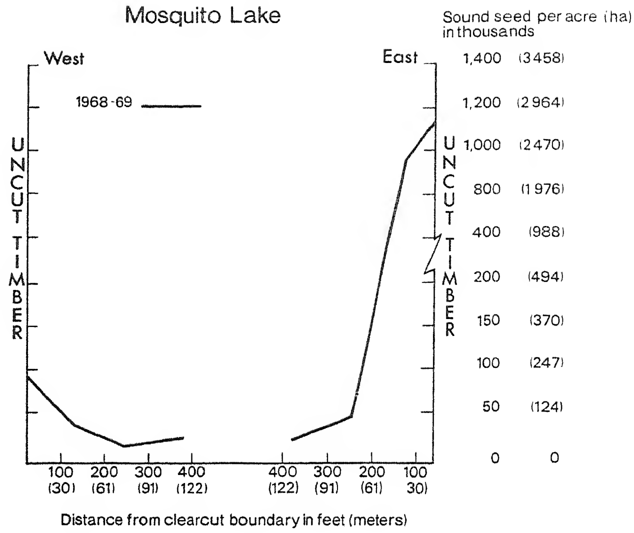
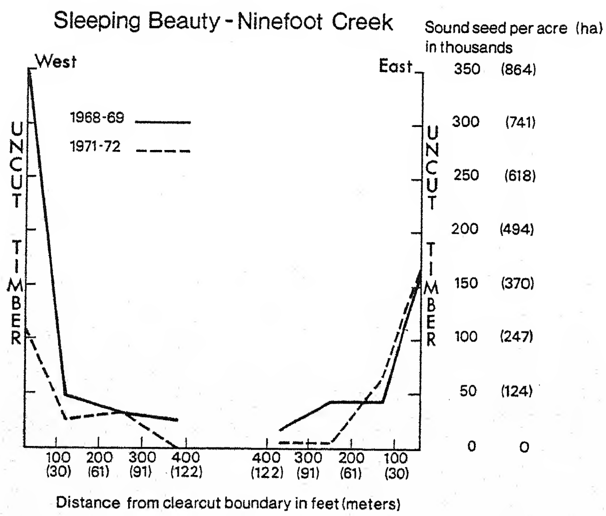


Figure 3.--Average seed fall from the 1968-69 and 1971-72 noble fir and Pacific silver fir seed crops, by distance from east and west clearcut boundaries.



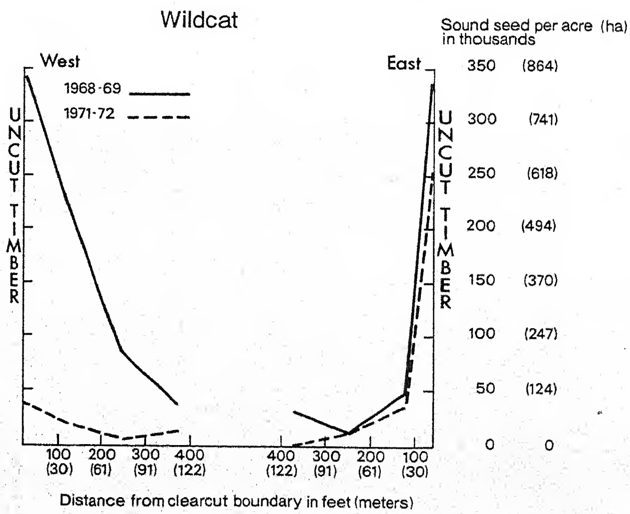


Table 3--*Regression models for total seed fall, seed years 1968-69 and 1971-72 combined, by area and by stand edge*

Species and location	Stand edge	Regression model[1/]	
Noble fir:			
Wildcat	East	Log (y + 1) = 1.9 + 0.74 (1/(x + 1))	
	West	Log (y + 1) = 2.2 + 0.13 (1/(x + 1))	N.S.
Bingham Ridge	East	Log (y + 1) = 2.7 - 0.12 (1/(x + 1))	N.S.
	West	Log (y + 1) = 2.5 + 0.38 (1/(x + 1))	
Sleeping Beauty	East	Log (y + 1) = 2.0 + 0.78 (1/(x + 1))	
	West	Log (y + 1) = 2.0 + 0.61 (1/(x + 1))	
Pacific silver fir:			
Mosquito Lake	East	Log (y + 1) = 2.5 - 0.32 (1/(x + 1))	N.S.
	West	Log (y + 1) = 1.3 + 0.69 (1/(x + 1))	

[1/] Significance level of t-test statistic for regression model was calculated at the 5-percent level; N.S. - nonsignificant.

has declined by two-thirds. About 10 percent of the seed of both species were collected at 375 feet (114 m). Sound and unsound seed of noble fir behaved similarly (table 4); that is, the percentage of sound and unsound seed at various distances from the stand edge are about the same. Unsound Pacific silver fir seed did fly farther on the average than sound seed, and the percentage of unsound seed at 125 feet (38 m) increased as distance from the stand edge increased (table 4).

There are some major differences between east and west stand edges in both the absolute level and the distribution of seed fall as distance from the stand edge increases (fig. 3) (table 5). Stand condition

Table 4--*Noble and Pacific silver fir seed trapped at various distances from the stand edge*

Species and seed type	Distance in feet (meters)			
	0	125 (38)	250 (76)	375 (114)
	Percent			
Noble fir:				
Sound	59	19	13	9
Unsound	56	21	13	10
Average	57	20	13	10
Pacific silver fir:				
Sound	41	34	16	9
Unsound	32	37	18	13
Average	37	35	17	11

Table 5 --*Seeds collected on the transects at the east and west sides of clearcut units, seed years 1968-69 and 1971-72 combined*

Species and area	Side of clearcut			
	West		East	
	Number	Percent	Number	Percent
Noble fir:				
Bingham Ridge	609	35	1,155	65
Wildcat	622	57	466	43
Sleeping beauty-Ninefoot Creek	444	50	444	50
Pacific silver fir:				
Mosquito Lake[1/]	80	7	1,023	93

[1/] Only 1968-69 seed year.

appears to be the primary factor influencing the total amount of seed. Of the three noble fir areas, Bingham Ridge had the most striking contrast in seed fall on east and west sides of the clearcut. Bingham Ridge also had the largest difference in basal area between east and west: 410 ft^2 per acre (94 m^2/ha) and 171 ft^2 per acre (39 m^2/ha)(table 2). At Wildcat, though there were more trees per acre on the east edge, the major factor affecting noble fir seed fall was apparently the high basal area per acre of noble fir on the west edge; basal area of noble fir on the west edge is over 1-1/2 times larger than on the east edge.

There are no consistent differences in the rate at which seed fall declines with distance between east and west clearcut boundaries (fig. 3). For example, at Wildcat noble fir seed dispersal was more effective from the west boundary in 1968-69 and from the east boundary in 1971-72. At Bingham Ridge dispersal of noble fir seed was more effective from the east boundary both years.

The percentage of sound noble fir seed from the 1968-69 and 1971-72 seed years ranged from 17.4 to 48.0. Total seed fall was higher in 1968-69 than in 1971-72, but the percentage of sound seed was lower, 21.0 versus 34.7 percent:

Area	Percent of sound seed	
	1968-69	1971-72
Wildcat	24.8	24.3
Bingham Ridge	20.5	48.0
Sleeping Beauty-Ninefoot Creek	17.4	31.8
	21.0	34.7

At Mosquito Lake 51 percent of Pacific silver fir seed was sound in the 1968-69 seed year.

DISCUSSION

The rapid decline in seed fall as distance from the stand edge increases is similar to results found with other upper-slope tree species--mountain hemlock (Franklin and Smith 1974a) and white and shasta red fir (Franklin and Smith 1974b). Response has been similar for light-seeded species--lodgepole pine (*Pinus contorta* Dougl.) in south-central Oregon (Dahms 1963), spruce-fir (*Picea* A. Dietr. *Abies* Mill.) in eastern Maine (Randall 1974), and Engelmann spruce (*Picea engelmannii* Parry) in the Rocky Mountains (Roe 1967).

Despite the rapid decline in seed fall as distance from the stand edge increases, large numbers of seeds are dispersed at least 375 feet (114 m) in bumper years. Average seed dispersed per acre for this distance in the 1968-69 year were 33,000 noble fir and 125,000 Pacific silver fir. Given reasonably favorable conditions for seed survival and germination and seedling establishment, these figures suggest more than adequate supplies of seed for natural restocking of small--10- to 20-acre (4- to 8-ha)--clearcuts.

The comparison of east and west cutting boundaries was an attempt to determine whether a primary direction of dispersal could be identified. A predominance of either southwest or east winds as the dispersal agent would presumably be responsible. Unfortunately, the data are insufficient to allow any conclusions.

The Bingham Ridge clearcut was a special case with the east and west transects sharing the set of seed traps at 375 feet. In this area seed from the dense noble fir stand on the east boundary of the clearcut appeared to be dispersed beyond the center of the unit in sufficient numbers to cause a skewed pattern in seed fall (fig. 3). Gratkowski (1958) observed a similar asymetrical pattern in Shasta red fir seed fall on a small clearcut.

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